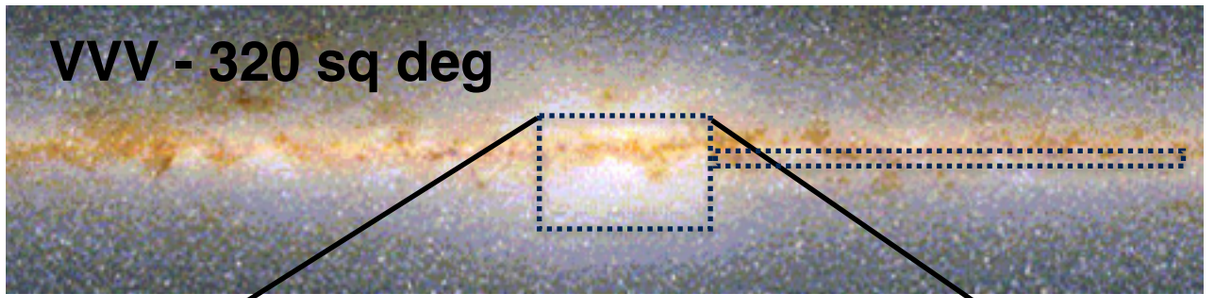
# Large scale structure in the Inner Milky Way

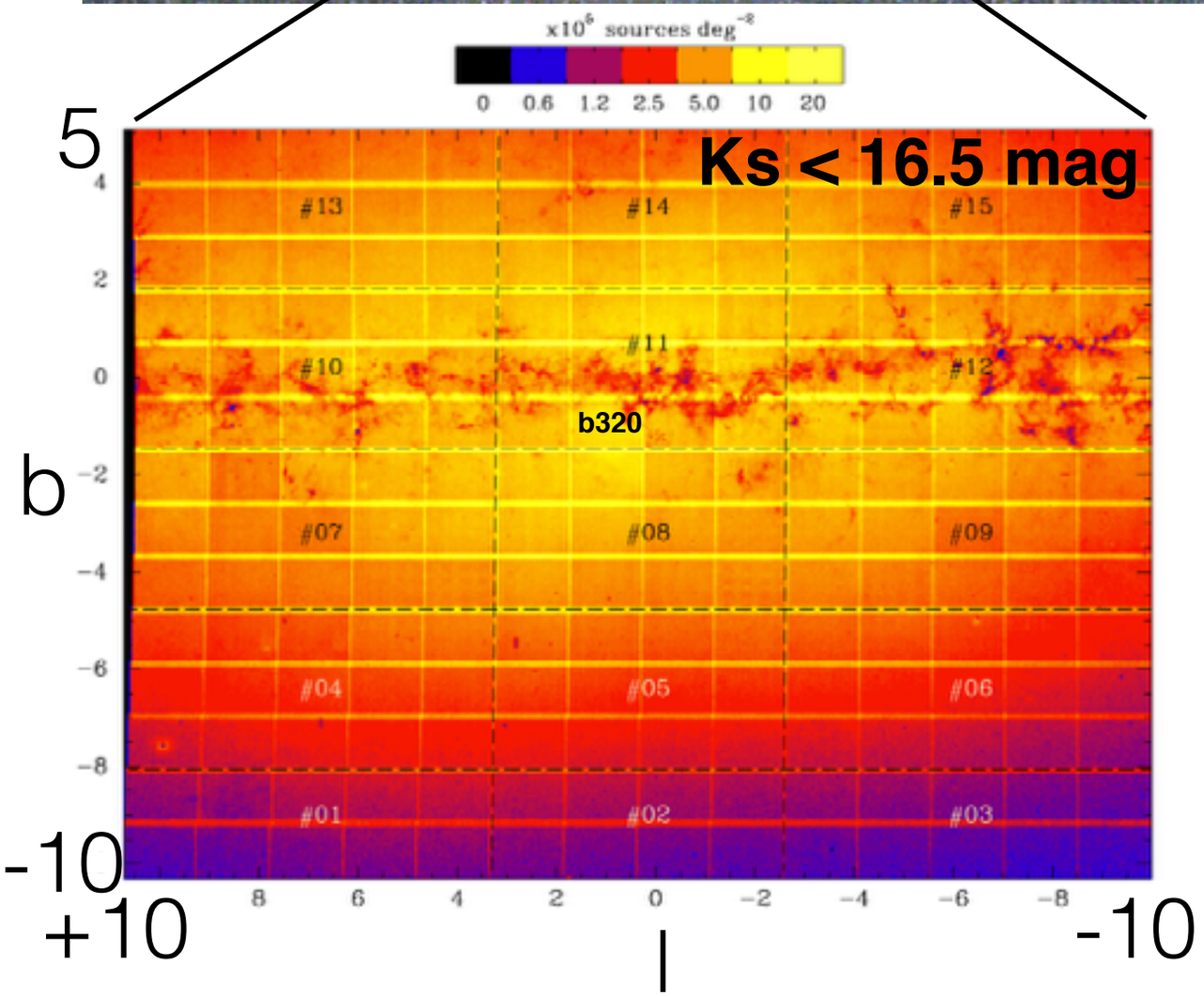
## The Milky Way unraveled by Gaia

Iulia Simion
V. Belokurov, M. Irwin, S. Koposov

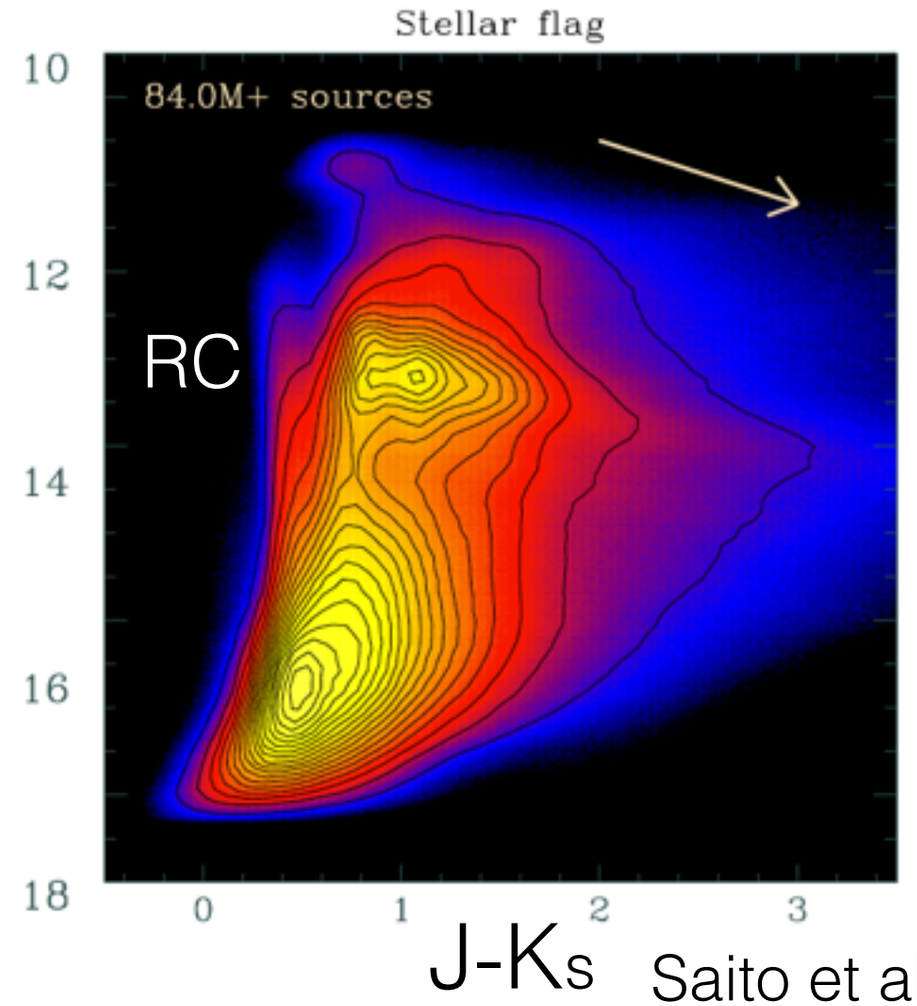
Barcelona, 04/12/2014

# VVV - a near IR survey
# ~4mags deeper than 2MASS



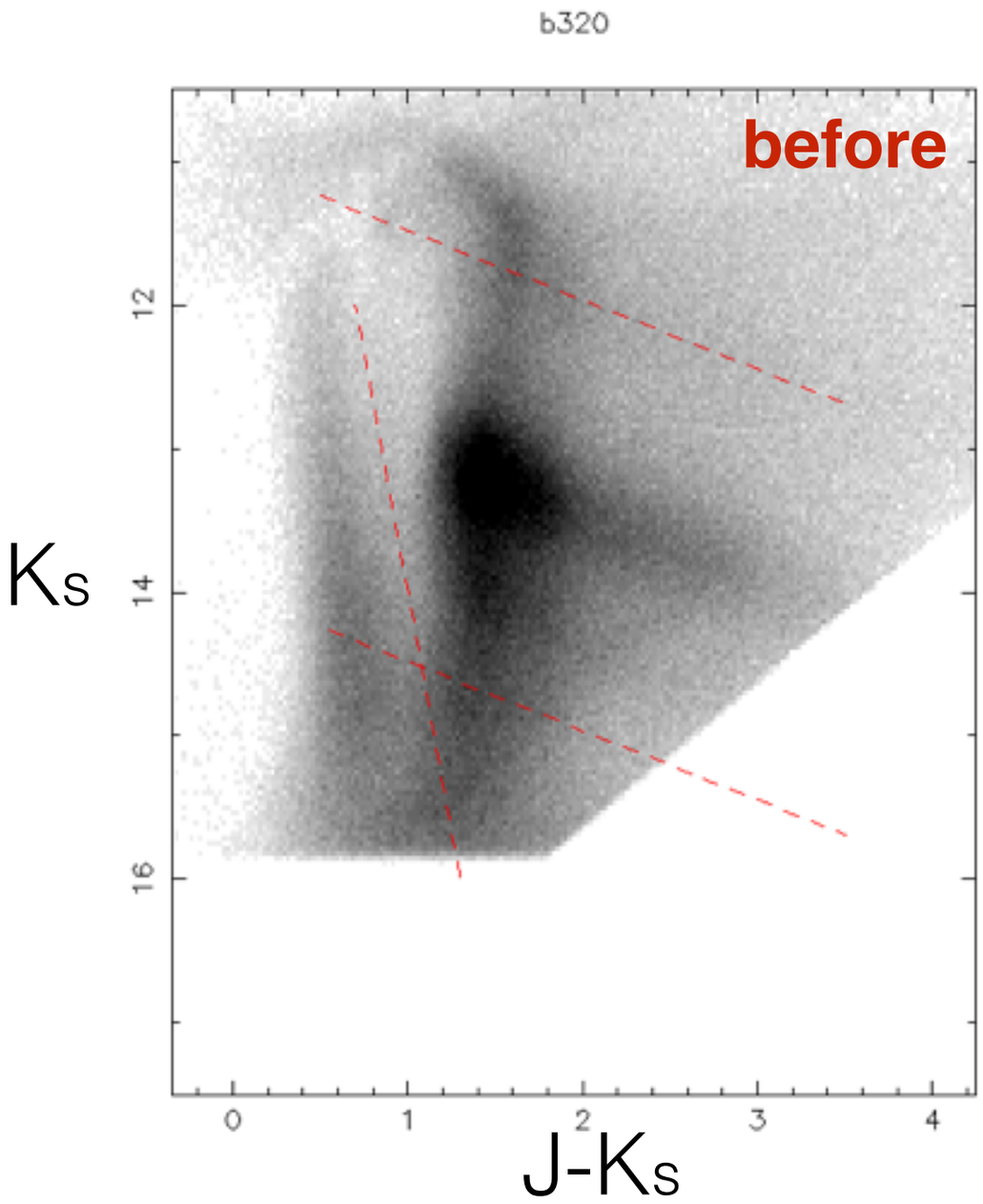

The bar/bulge hold key info about the **formation** and **evolution** of spiral galaxies

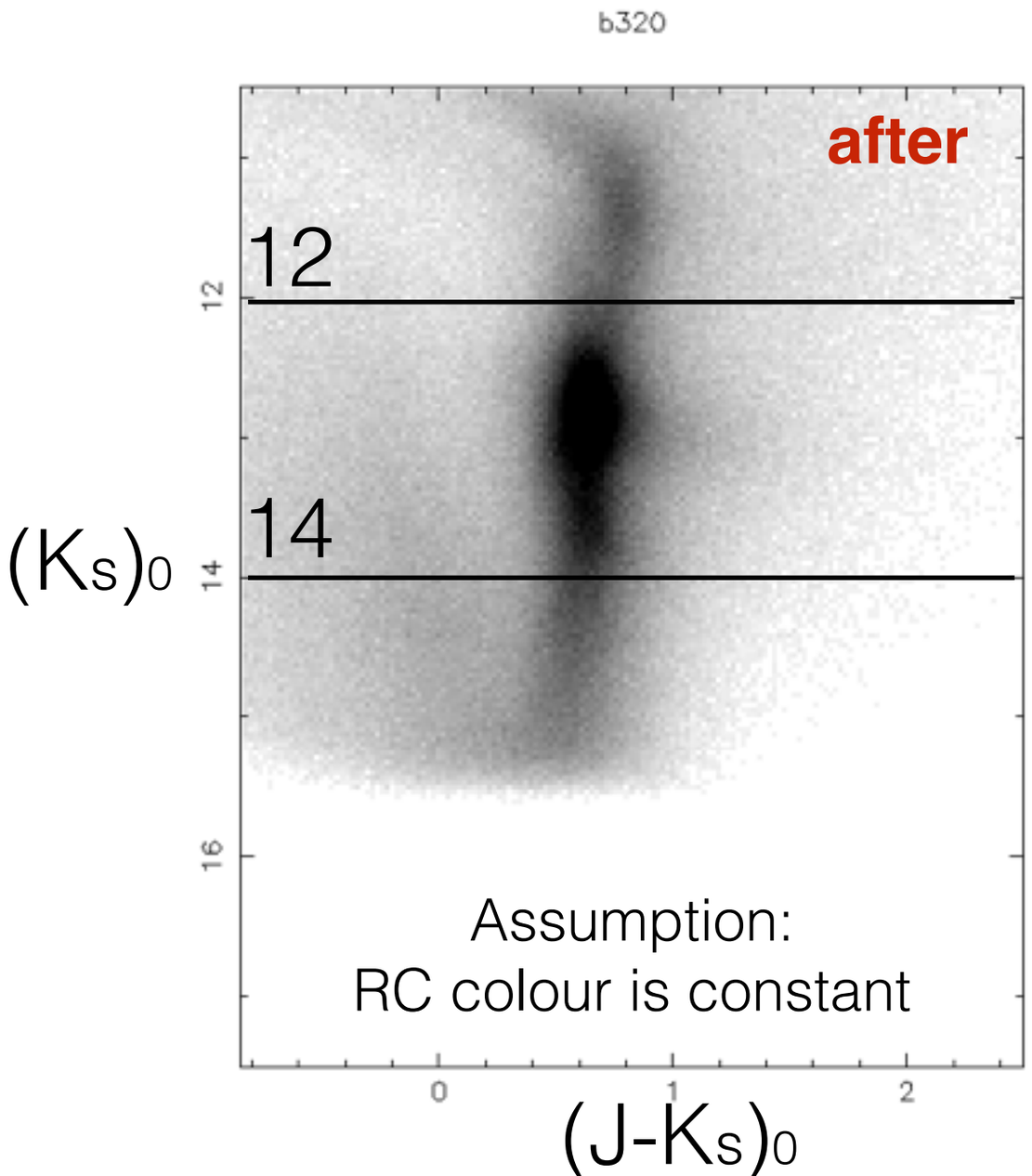



Saito et al. (2012)

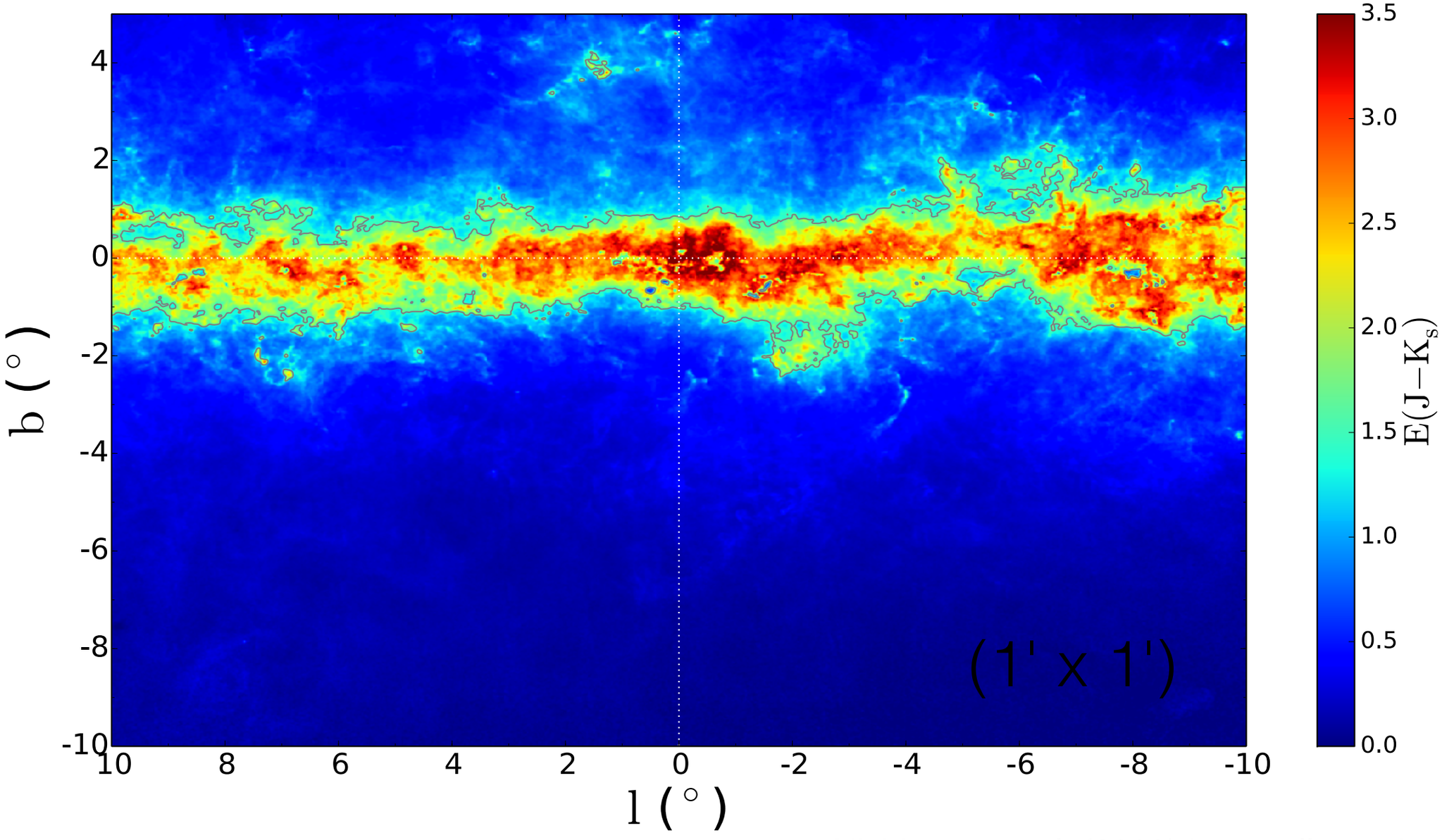
# The reddening problem

see Gonzalez et al. 2011



# The reddening problem




Nishiyama et el. (2009) interstellar extinction law

# The star counts model

**5 free parameters**

$$N_{obs}^{VVV} = N_{discs}^{model} + N_{bulge}^{model} = S * N_d^{Besancon} + \int_0^{\infty} \rho_b(r)\,\phi_b(M_{K_s})\,\Omega r^2 dr$$

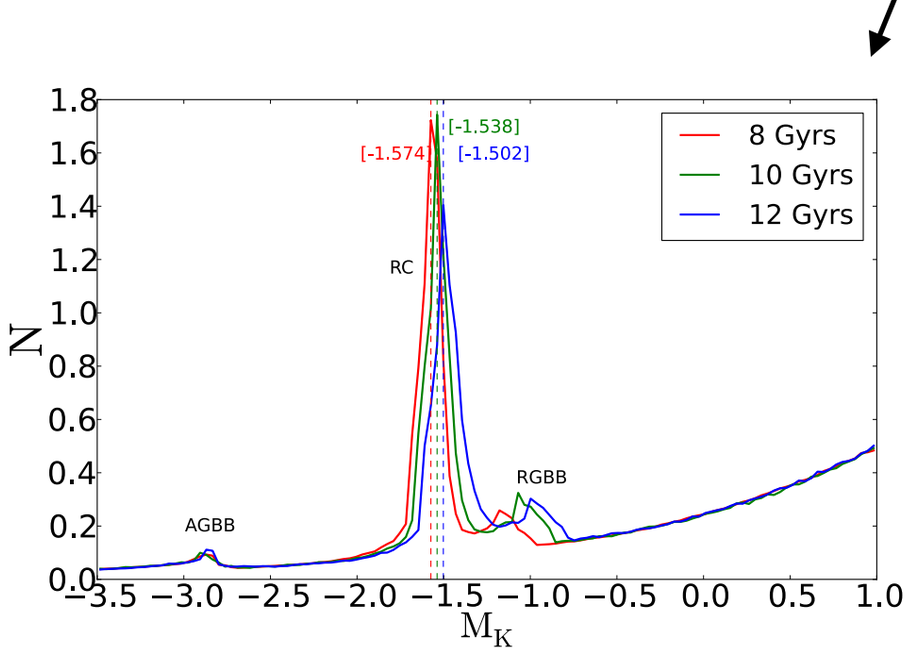
(Robin et al. 2003)

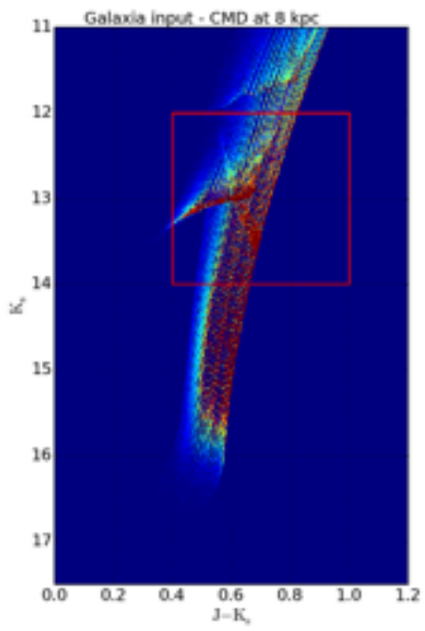
LF

$$\rho_b = \rho_0 \exp^{-0.5 r_s^2}$$

$$r_s^2 = \sqrt{\left[\left(\frac{x}{x_0}\right)^2 + \left(\frac{y}{y_0}\right)^2\right]^2 + \left(\frac{z}{z_0}\right)^4}$$

‘boxy’ Gaussian
(Dwek et al. 1995)

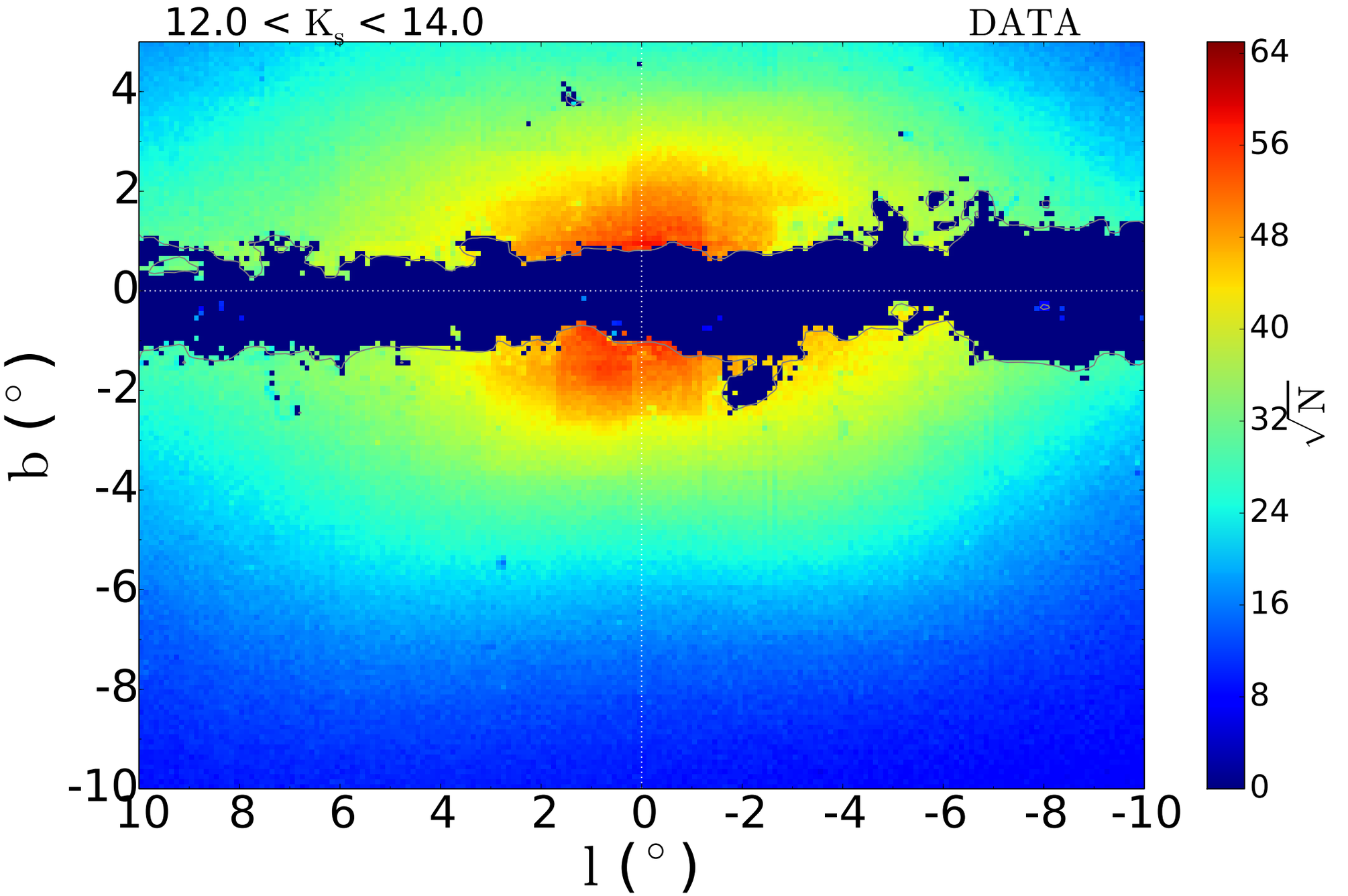


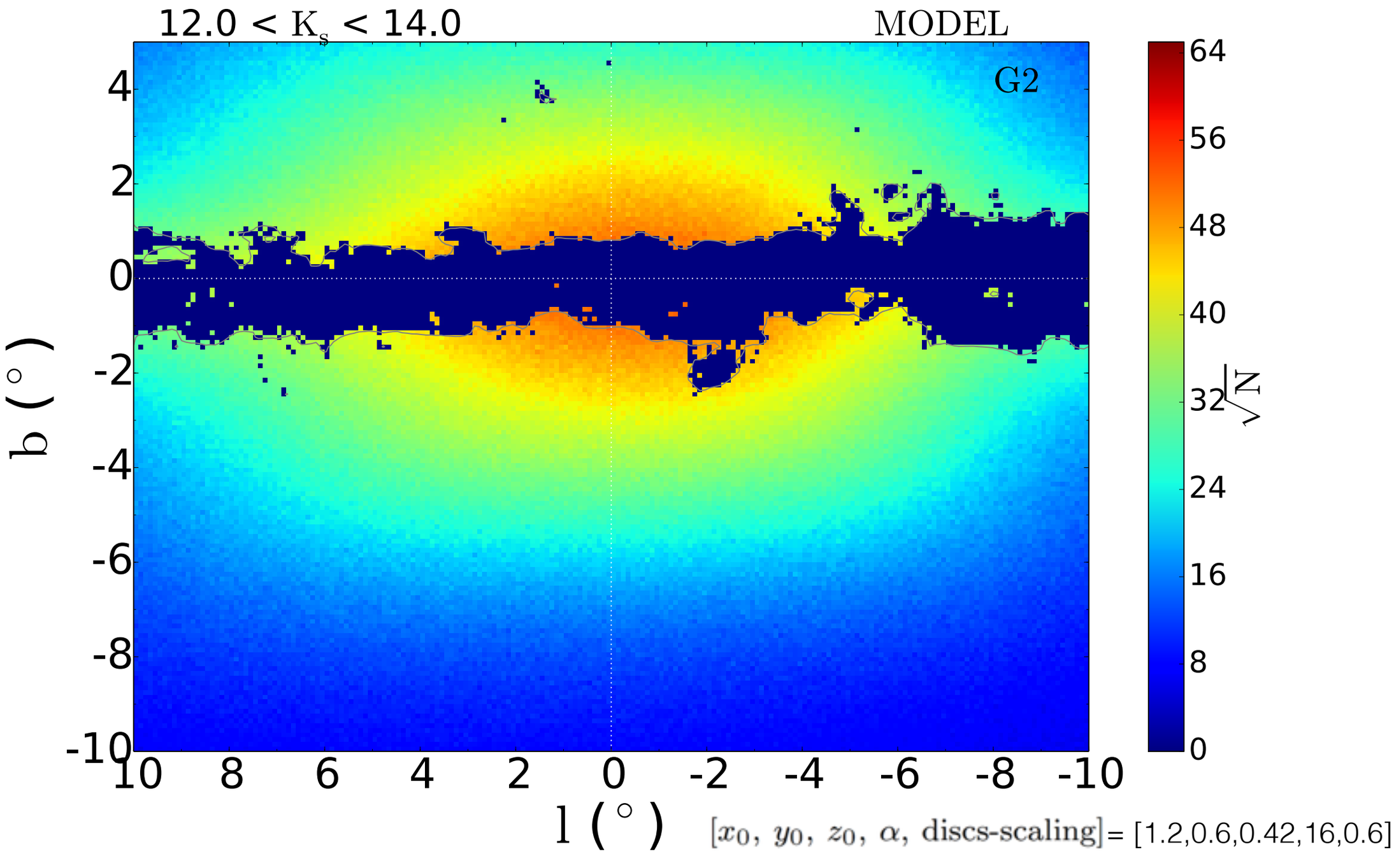

Age = 10 Gyrs, [Fe/H] = 0±0.4 dex
Padova isochrones (Bressan et al. 2012)

$\alpha$ = bar rotation angle

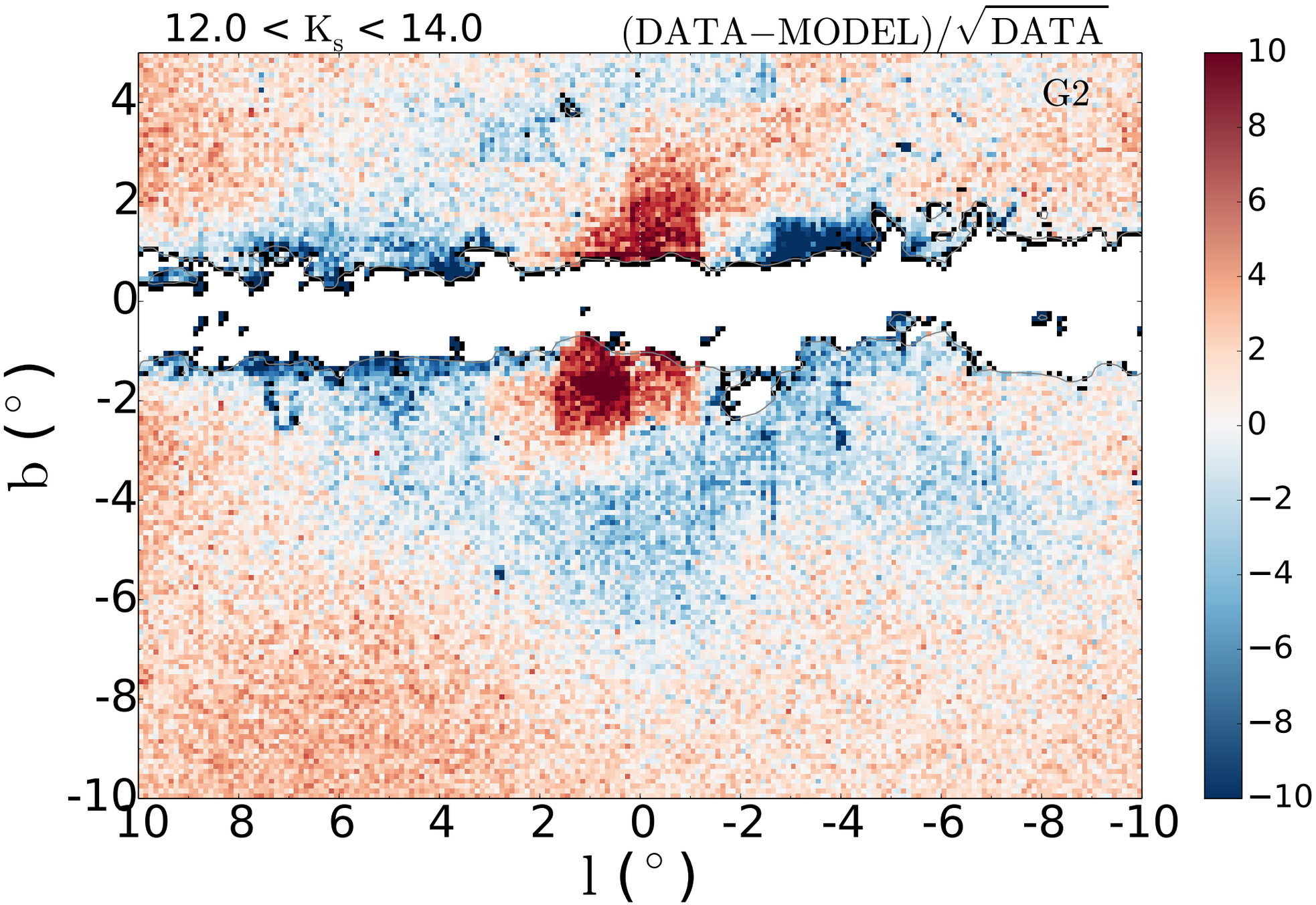
# The data


12.0 < K$_s$ < 14.0
DATA
b (°)
l (°)
√N
64
56
48
40
32
24
16
8
0
4
2
0
-2
-4
-6
-8
-10
10
8
6
4
2
0
-2
-4
-6
-8
-10

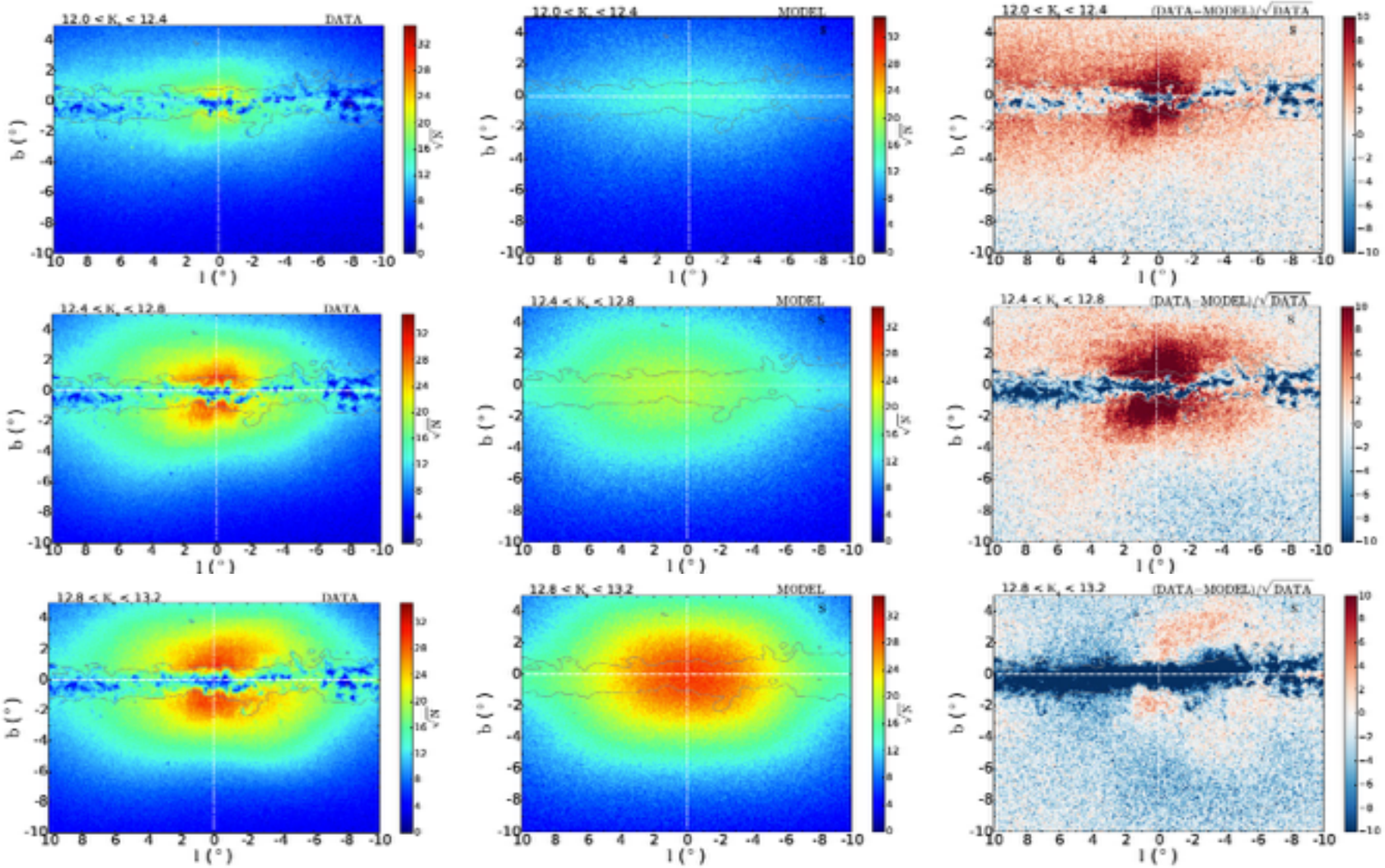
# The model


12.0 < K_s < 14.0
MODEL
G2
b (°)
l (°)
√N
64
56
48
40
32
24
16
8
0
4
2
0
-2
-4
-6
-8
-10
10
8
6
4
2
0
-2
-4
-6
-8
-10
[x0, y0, z0, α, discs-scaling]= [1.2,0.6,0.42,16,0.6]

# Residuals


12.0 < K_s < 14.0
(DATA−MODEL)/√DATA
G2
b (°)
l (°)
4
2
0
-2
-4
-6
-8
-10
10
8
6
4
2
0
-2
-4
-6
-8
-10
10
8
6
4
2
0
−2
−4
−6
−8
−10

DATA MODEL RESIDUALS




12.0<K<12.4

12.4<K<12.8

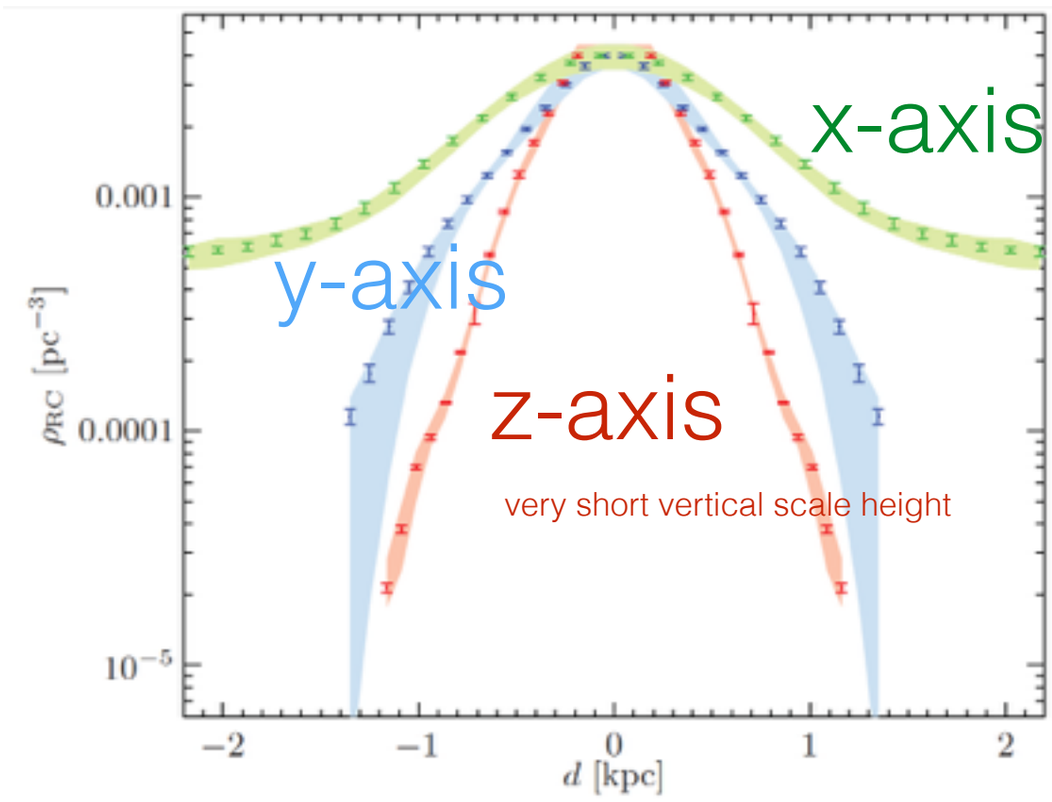
12.8<K<13.2

13.2<K<13.6

13.6<K<14.0

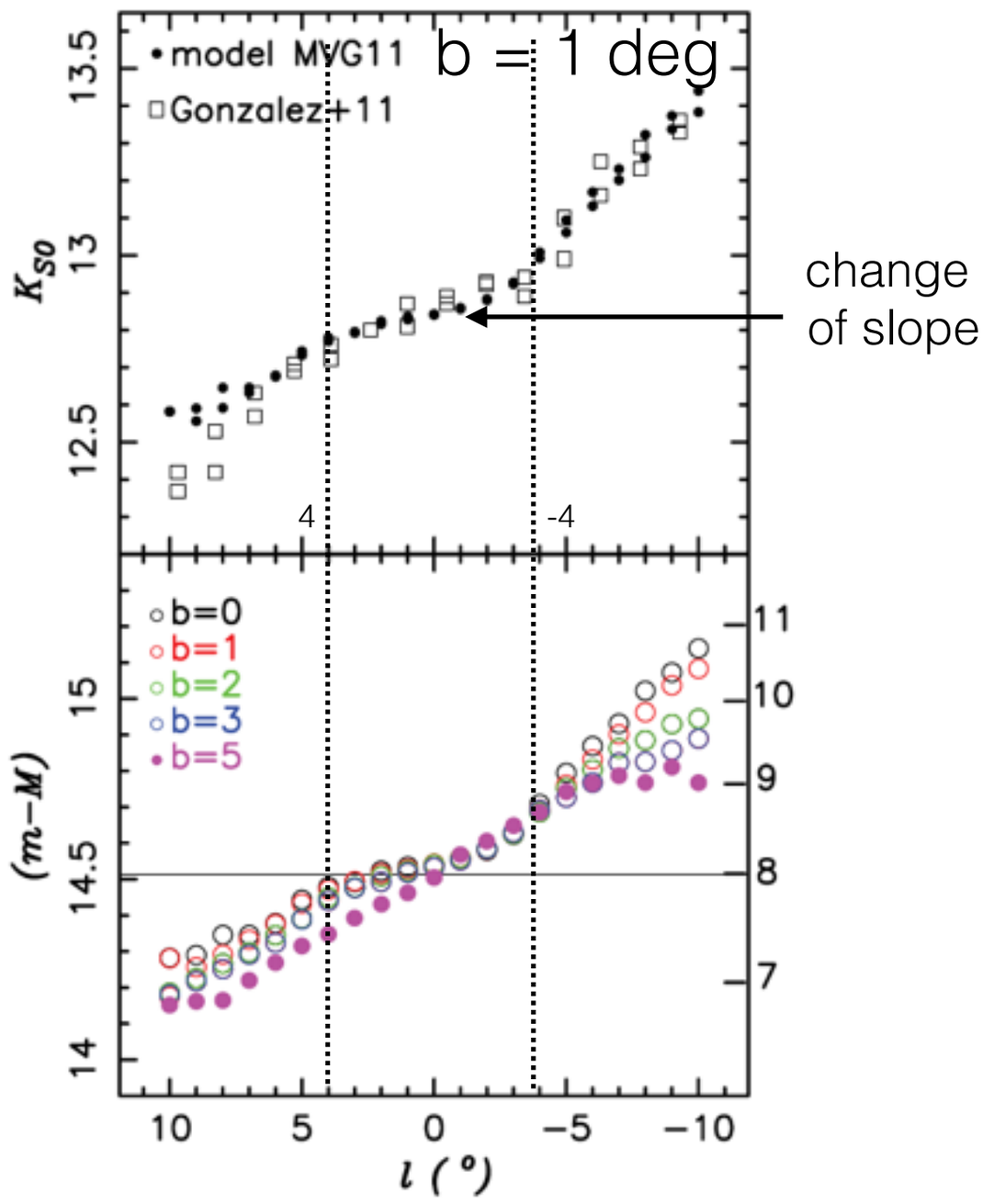
# Disky pseudo-bulge?
# Red Clump stars studies

Wegg & Gerhard (2013)




density RC stars vs d [kpc]

Gerhard & Martinez-Valpuesta (2012)



# Discs?

Thick disc (Reyle & Robin (2001)):
scale length = **2.5** kpc
scale height = 800 pc

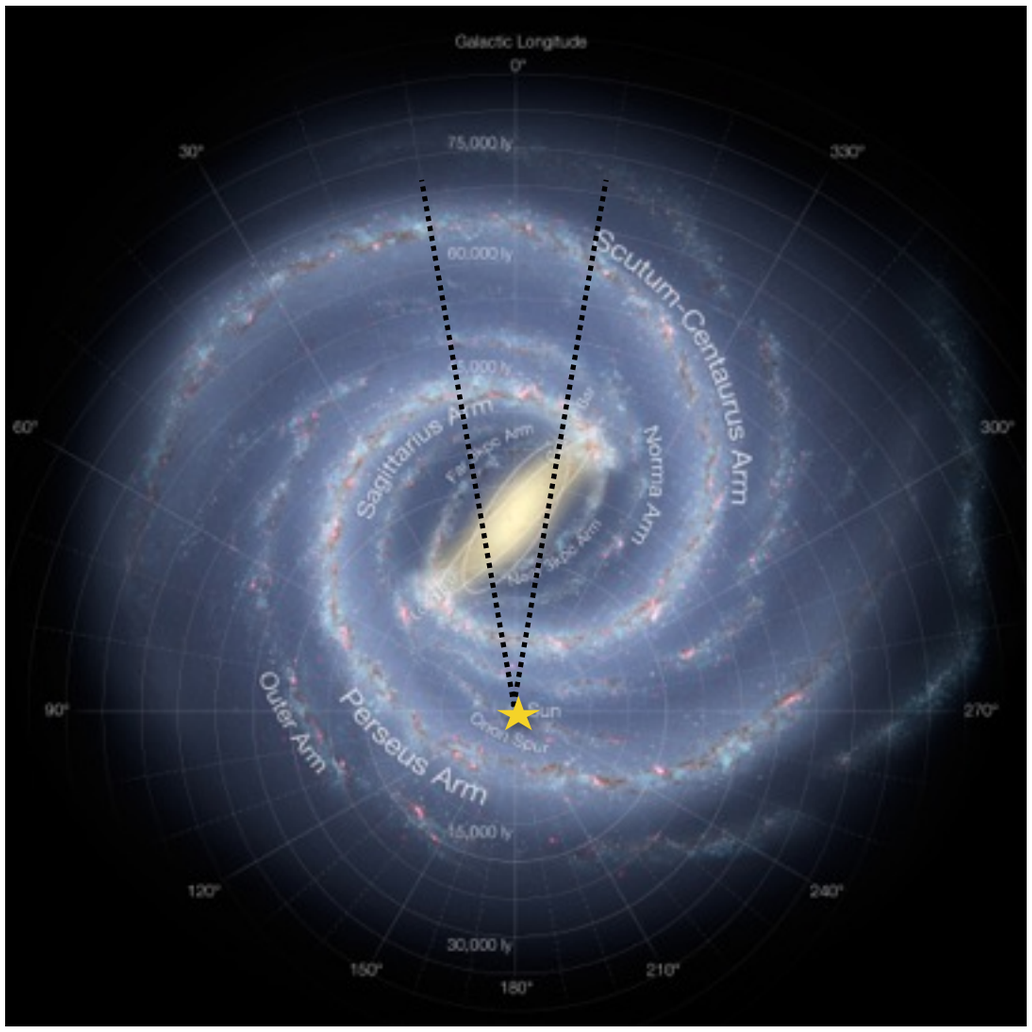
Thick disc (Robin et al. 2014):
scale length = **2.3** kpc
Increase in the density at the Galactic Centre by 32%
no need for a pseudo-bulge

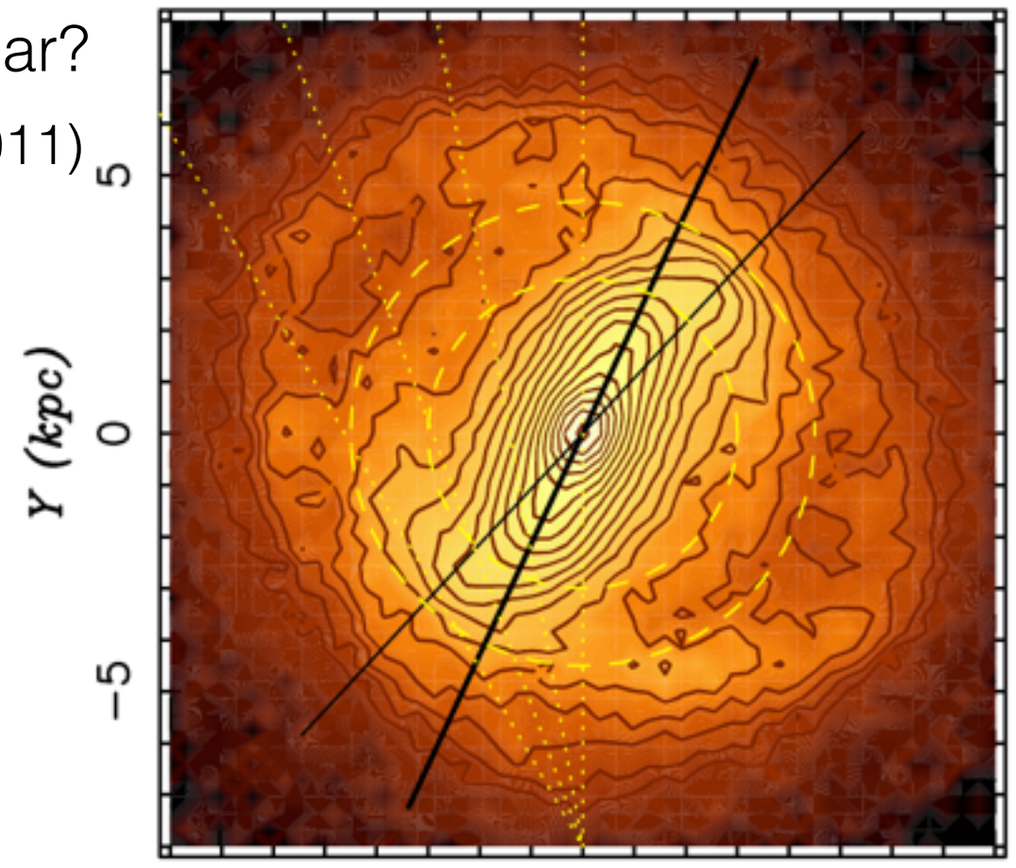
(see A. Robin's talk)

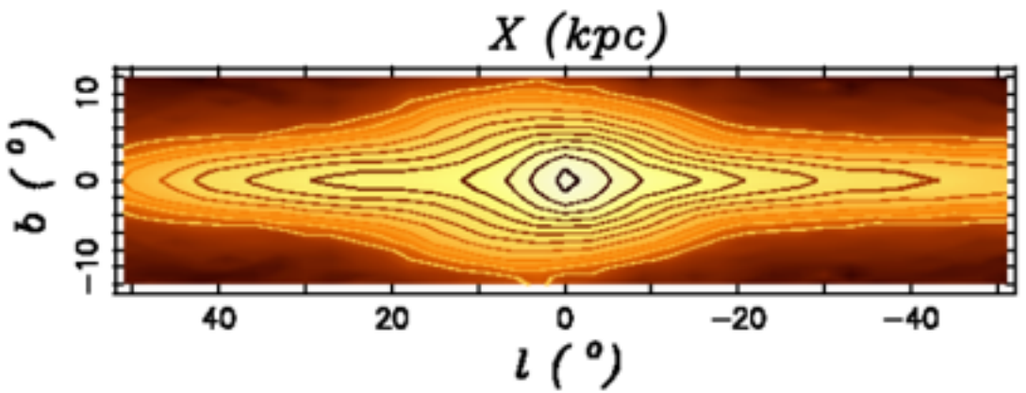
# Spiral arms overdensity?

leading/trailing overdensities at the end of the bar?

(Martinez Valpuesta-Gerhard 2011,Romero-Gomez 2011)



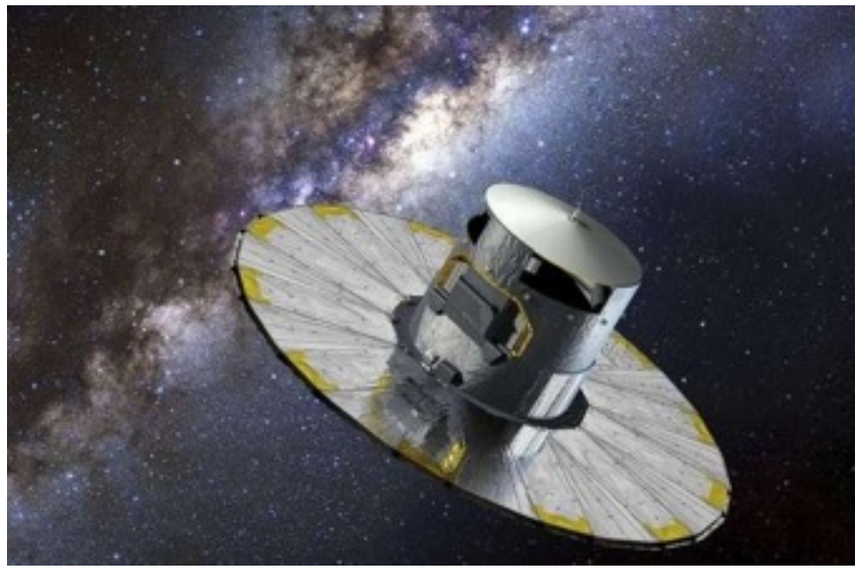



# Conclusions

VVV data allows us to:

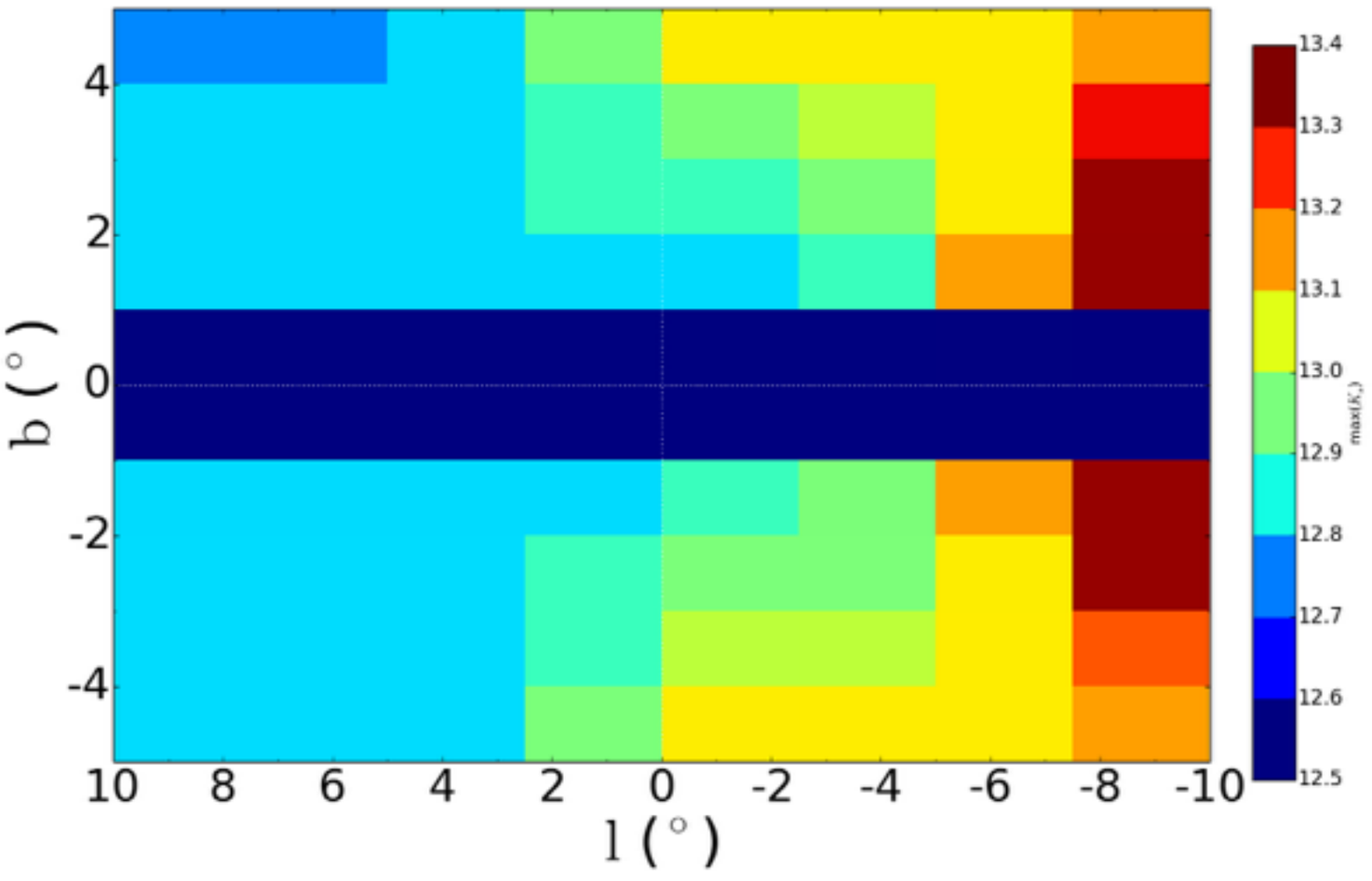
- Obtain extinction maps sensitive to small scale variations;
- study the bulge density distribution;
- put constraints on the different processes that drive the history of Galactic assembly.

Gaia will soon provide us data for the motions of the stars and it will allow us to deduce the dynamical history of the populations in the inner regions of the Galaxy.



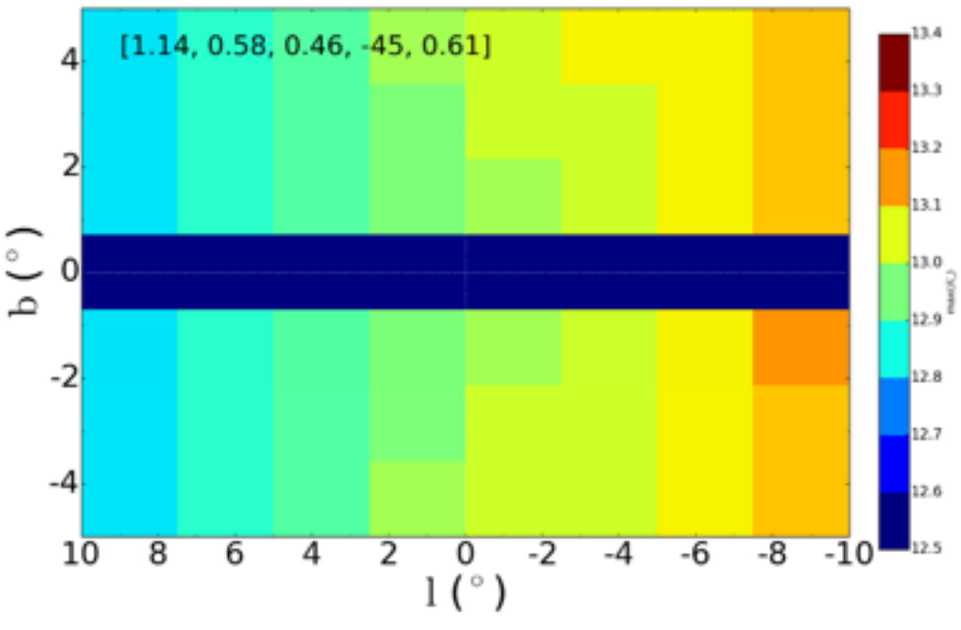
# Spiral arms?

Data

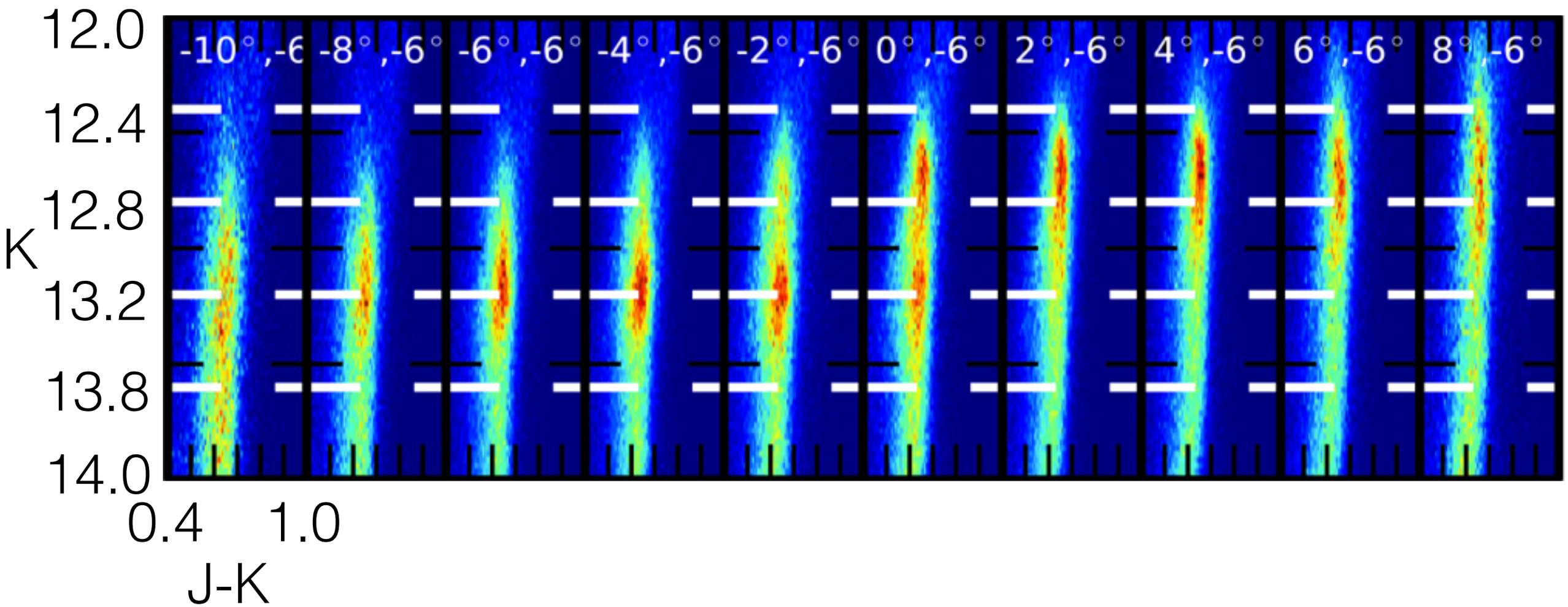


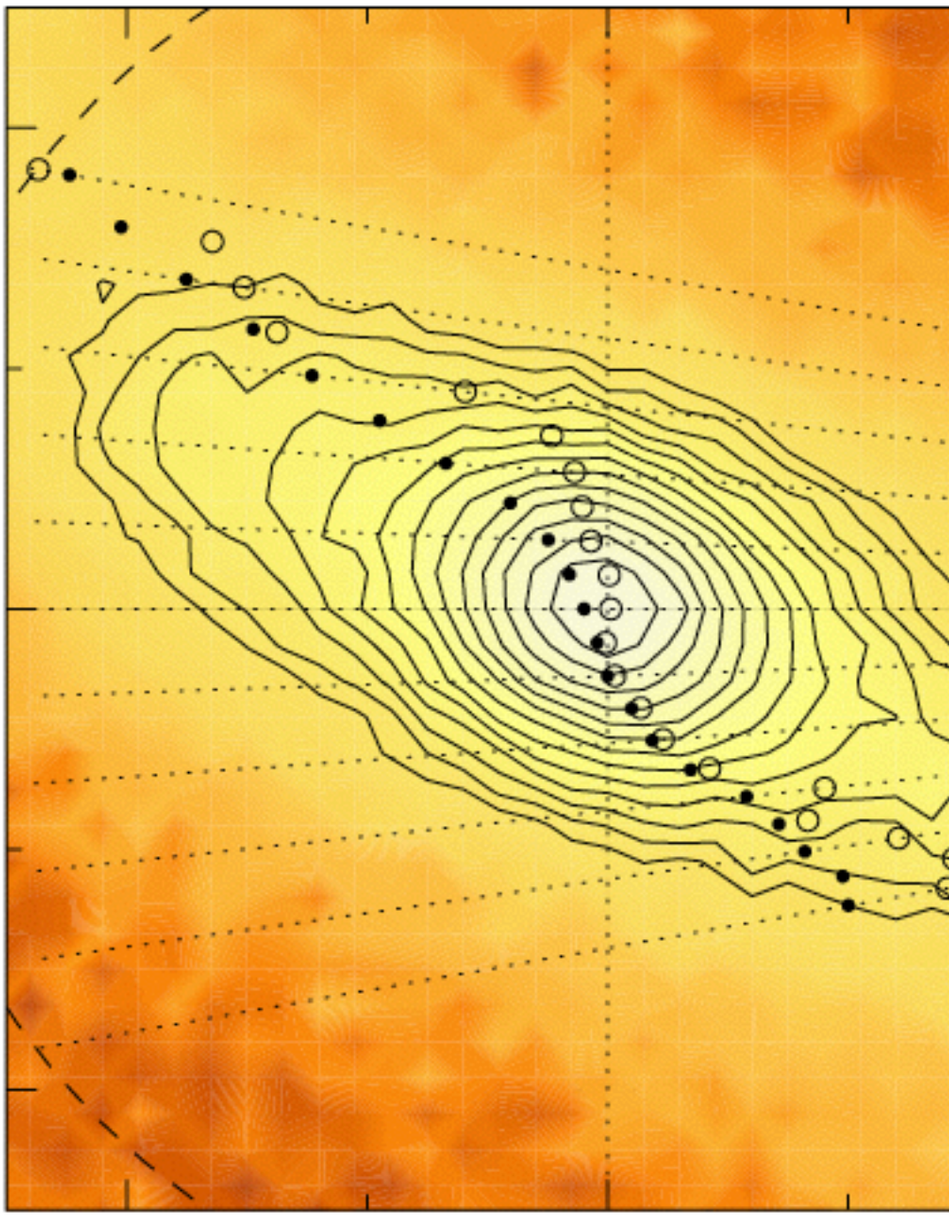

see McWilliam & Zoccali 2010, Fig. 5

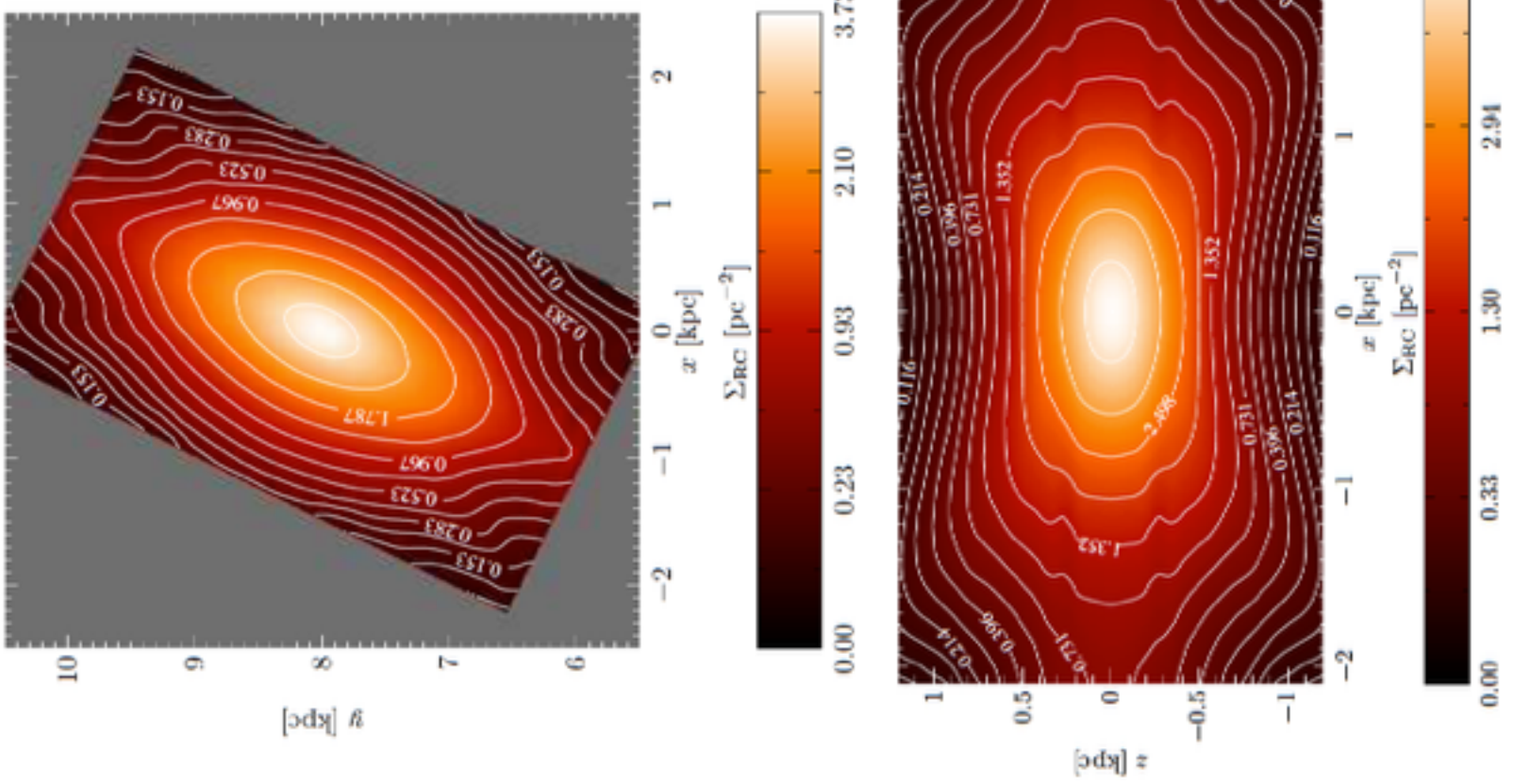
Model (45 deg)



# CMDs




Y (kpc)
X (kpc)
2
0
−2


y [kpc]
x [kpc]
$\Sigma_{RC}$ [pc$^{-2}$]
0.00
0.23
0.93
2.10
3.73
0.153
0.283
0.523
0.967
1.787
z [kpc]
0.00
0.33
1.30
2.94
5.22
0.116
0.214
0.396
0.731
1.352
2.498

$$\rho_b = \rho_0 \exp^{-0.5 r_s^2}, \quad \text{if} \quad R < R_c$$

$$\rho_b = \rho_0 \exp^{-0.5 r_s^2} \exp^{-0.5\left(\frac{R-R_c}{0.5}\right)^2}, \quad \text{if} \quad R > R_c$$

$$N_{obs}^{VVV} = N_{discs}^{model} + N_{bulge}^{model} = S * N_d^{Besancon} + \int_0^{\infty} \rho_b(r) \phi_b(M_{K_s}) \Omega r^2 dr$$